Responsive Novelty: Taking Innovation Seriously in Research Agendas for Synthetic Biology

Sujatha Raman, Deputy Director, Leverhulme *Making Science Public* Research Programme & Institute for Science and Society (ISS), University of Nottingham and Visiting Scholar, Consortium for Science, Policy and Outcomes (CSPO), Arizona State University

The Research Problem

Approaches in synthetic biology have been put forward as novel options for addressing grand challenges such as climate change and antimicrobial resistance.[1] In this context, societal research agendas must include the following questions:

What might constitute novelty in domains interpolated by synthetic biology; according to which criteria; and as determined by whom? Can different visions of novelty be creatively synthesised - if so, how, and to what effect?

At first, such questions seem contrary to the goals of developing a societal agenda around synthetic biology (SB) research. Societal research is normally expected to fill in the gaps in knowledge produced by scientists and engineers, exploring questions that are not formally part of the scientific/technical agenda for investigation. Such presumed knowledge gaps include questions of the following nature. What are the ethical implications of developing and using SB applications? How do different public and stakeholder groups perceive SB? What might be the unforeseen side-effects of SB? How should SB research and innovation be regulated? These are all important questions. But, as many social researchers have pointed out, the institutional arrangements and norms that structure how research in SB and other emerging technology areas is done and validated have inadvertently created their own blind-spots and knowledge gaps.[2] The gap in knowing how to make social dimensions really matter to research and innovation is particularly glaring for reasons outlined below.

- Social/ethical matters are treated as *spatially*, *temporally* and *substantively* separate from technical ones. That is to say, they are seen as lying outside the normal spaces of scientific research (e.g., laboratories, journals), to be determined by non-scientists (e.g., ethicists, social scientists, publics, stakeholders, policymakers) either before technical work begins or after technical challenges have been solved, and to be about opinions and values that cannot themselves be incorporated into research practice.[3]

- These divisions mean we know a great deal about how to *elicit* different societal perspectives but less about how to *integrate* them into research so that ethical questions such as those framed in terms of 'social' or 'economic' sustainability (e.g., justice, equality, livelihood, human well-being) come to be investigated simultaneously and together with scientific/technical ones. [4]

- This demarcation arises because scientists and engineers are expected to determine what is novel or innovative while social scientists and ethicists are expected to determine how innovation can be done responsibly. In neither case is the question of what constitutes or might constitute innovation considered worthy of systematic investigation in its own right. Rather, what is novel is taken to be a given at the *start* of new research rather than as a *subject* of this research.

- The need for more integration of the social and the scientific is important because interventions for innovation are frequently experienced as being *not innovative enough,*

even where the fulfilment of societal need is meant to be its purpose.[5] Rather than treating this lack as a problem of societal resistance or lack of responsibility, it is at least equally valid to take it to be one of insufficient novelty if SB or other emerging technologies are seen as extensions of existing socio-economic-systems and their problems.

- There is insufficient attention paid to a.) ways in which a specific intervention might or might not be novel according to different actors and b.) the landscape of different visions for novel interventions.[6] These aspirations are central to ideas of responsible innovation that emphasise the need to open up the innovation process to different visions of innovation, thereby asking not only '*what if*' questions (e.g., what if a technology produces undesirable impacts) but also '*what else'* ones (e.g., how can innovation be done differently). For example, bioenergy is likely to require significant changes in agri-economic and global trade systems in conjunction with technological novelty if it is to be really innovative. [7] If synthetic biology is to be applied to bioenergy, this challenge will need to be considered.

Societal Approaches to Researching Novelty

Expanding and investigating the landscape of novelty in response to different visions of innovation (hence, *responsive novelty*) requires more support for integrative approaches. One approach is to begin with lab-based research projects or methods and look for ways of integrating societal matters into these domains. Examples include the socio-technical integration of research (STIR) framework, anticipatory life cycle assessment, and systems engineering.[8] We also need approaches that begin from outside of the lab in policy, economic and socio-cultural systems and work their way back in – these might draw from problem structuring methods and whole system analysis in policy studies. The key with all of these is to draw out the novel insights that emerge from these different interfaces to clarify that the social is not merely an add-on, but is rather central to generating knowledge for innovation.

In conclusion, I will look briefly at how this might work around SB approaches to drug discovery in the face of antimicrobial resistance (AMR).

Investigating Epistemic novelty – It has been suggested that SB approaches to new antibiotics would pre-empt the development of resistance because of their novel biological mechanism of action. A key societal question for research would be to investigate this further by looking at how representatives of different scientific, clinical, epidemiological and healthcare fields envision novelty in the face of antimicrobial resistance. For example, how do advocates of evolutionary medicine or imagine novel solutions to AMR and how do these compare with SB? Eliciting different perspectives could be followed by integrative exercises in problem structuring and synthesis, keeping in mind that not all differences can be reconciled and reporting needs to be transparent on what has been left out.

Investigating Socio-economic novelty – A recent policy paper on synthetic biology for AMR suggests that SB approaches are highly efficient, hence representing an economically attractive option for less-affluent parts of the world where infectious diseases are more of a threat.[9] Here, one might look at which socio-economic and institutional models would allow SB to be innovative rather than assume that SB is intrinsically novel because of its efficiency. One could also draw on knowledge and experience of how poverty not only shapes the spread and impacts of disease *but also* the impact of technological interventions (medicines) on the body, investigate what might be done about this and then ask where SB fits in this broader picture.[10]

In conclusion, to make societal research on emerging technologies matter, we need to respond to the possibility of innovating in social, industrial, economic, policy and cultural systems as much as and in conjunction with technological innovation.[11] This might allow for synthetic biology to be novel in ways not envisaged within current market-based economic models (for example, by creating the space for new ways of building social value rather than just private value). It might also allow for ways of transforming the social world (for example, dealing with poverty and inequality) to be explored in conjunction with SB rather than taken to be separate from it. Through this there may be opportunities for synthetic biology to reconnect with older visions of 'biological engineering' which were seen as distinctive from and a corrective to the problems of industrial systems.[12]

---

[1] While SB options for climate change have been widely considered (e.g., approaches to producing biofuels), the emerging case for SB for antimicrobial resistance requires more attention. See: BBC 2014. Novel antibiotic class created. http://www.bbc.com/news/health-29306807 ;Takano, E. and R.Breitling. 2012. Antimicrobial resistance – a new drug discovery perspective using synthetic biology. http://www.scienceforglobalpolicy.org/LinkClick.aspx?fileticket=ofplKrWuSG4%3D&tabid=162

[2] Balmer, A., et al 2012. Towards a manifesto for experimental collaborations between social and natural scientists. http://experimentalcollaborations.wordpress.com

[3] Balmer, A. S., & Bulpin, K. J. (2013). Left to their own devices: Post-ELSI, ethical equipment and the International Genetically Engineered Machine (iGEM) Competition. *BioSocieties*, *8*(3), 311-335.

[4] This challenge is articulated in recent work, e.g.: Wiek, A., Guston, D., Frow, E., & Calvert, J. (2012). Sustainability and anticipatory governance in synthetic biology. *International Journal of Social Ecology and Sustainable Development (IJSESD)*, *3*(2), 25-38. Raman, S., A.Mohr, R.Helliwell, B.Ribeiro, O.Shortall, R.Smith and K.Millar. 2014. Integrating social and ethical dimensions into sustainability assessment of lignocellulosic biofuels. Submitted

[5] This formulation of the problem of innovation is drawn from Safalaoh, Andy. 2014. The Elusiveness of pro-poor innovation benefits: lessons from the smallholder livestock sector in Malawi. PhD thesis, University of Nottingham.

[6] Owen, R., J.Stilgoe, P.Macnaghten, M.Gorman, E.Fisher & D.Guston. 2013. A Framework for Responsible Innovation. In R.Owen, J.Bessant & M.Heintz (eds) *Responsible Innovation*. John Wiley; Guston, D. H. (2013). Daddy, Can I Have a Puddle Gator?: Creativity, Anticipation, and Responsible Innovation. In Owen, Bessant & Heintz (eds), *Responsible Innovation*, John Wiley, pp. 109-118.

[7] See: https://andybalmer.wordpress.com/2013/07/30/can-scientists-engage-critically-with-capitalism/ ; Also, Raman et al. op cit 3.

[8] Schuurbiers, D., & Fisher, E. (2009). Lab-scale intervention. *EMBO reports*, *10*(5), 424-427. Wender, Ben A., et al. 2014. Anticipatory Life Cycle Assessment for Responsible Research and Innovation." *Journal of Responsible Innovation* 1-13. Allenby, B. (2000). Earth systems engineering and management. *Technology and Society Magazine, IEEE*, *19*(4), 10-24.

[9] See Takano and Breitling 2012, op cit 1.

[10] On the relationship between drugs, drug resistance and poverty, see the extensive work of Paul Farmer.

[11] I have explored this elsewhere in a policy think-piece: Raman, S. 2014. *Responsive Research? Putting the Innovative back into Agendas for Innovation.* Paper for Sciencewise-ERC, UK with contributions from M.Clifford, S. de Saille, D.Gent, S.Hartley, A.Mohr and T.Sesan. http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Responsive-ResearchFINAL-VERSION.pdf

[12] See Bud, R. (1994). *The uses of life: a history of biotechnology*. Cambridge University Press.